Brief Summary of 19 March 2018 report (Squires, et al. 2018)

The Rio Grande NF, in cooperation with the Rocky Mountain (R2) Regional Office, Rocky Mountain Research Station, and Colorado Parks and Wildlife, is developing new vegetation management direction for the revised forest plan to apply findings from a lynx-bark beetle response study on the Forest by Dr. John Squires and collaborators. Additional data and expertise of Dr. Jake Ivan, Colorado Parks and Wildlife wildlife researcher and lynx expert have also been integral to development of a new habitat lynx management approach on the Forest. The widely-changed forest conditions due to the effects of the bark beetle, ongoing salvage harvest program, and the Forest Service's interest in using the best available science to develop a focused conservation approach for Canada lynx and its habitat into the future, are principal considerations in developing the new direction.

The information provided in this summary analysis is intended to inform the forest plan revision effort on the Rio Grande National Forest. Given that the study has not yet been peer-reviewed, the information included in this document may change or be amended as Dr. Squires and collaborators prepare the research results for publication. Therefore, no information in this document should be published without the explicit permission of the Forest Service, Colorado Parks and Wildlife, and principal investigators.

The study area overlapped 377,513 acres of core lynx habitat in the San Juan Mountains, with the majority (344,642 acres or 91%) occurring on the Forest. The remainder of the study area overlapped part of the Grand Mesa, Uncompahgre and Gunnison national forests. The primary purpose of the study was to address management questions associated with the identification and maintenance of suitable habitat for lynx and primary prey species in spruce-beetle impacted forests. The study also informs ongoing post-beetle management activities, including timber salvage. The study evaluated lynx resource selection at two spatial scales. First, the landscape-level analysis characterized and spatially predicted resource use (i.e., selection) by lynx at a broad-regional scale. At the stand-level analyses characterized what forest attributes were being preferentially used by lynx. Relative to salvage activities, the landscape scale analysis informs where proposed salvage treatments may occur in relation to lynx habitat, whereas the stand-level analysis informs specific silvicultural prescriptions and recommendations.

The study utilized 11 GPS collared lynx (6 males, 5 females) captured from 2015-2017 to characterize what habitat components lynx are selecting during both winter and summer periods. This resulted in 11,628 locations for the winter and 7,721 during summer, which represents the sample of lynx resource use. Random samples representing approximately 7,000 locations per individual lynx were utilized to characterize availability across the study area at the landscape scale. With the sample of use and availability, resource selection function (RSF) models were built to examine selection behavior of lynx. Landscape variables were calculated at multiple scales to identify the best-supported model in predicting lynx resource selection. An abiotic model was identified as a base model of resource selection by lynx, which was then augmented with variables that described forest characteristics (e.g., canopy cover, sub-canopy tree densities) to further inform our understanding of lynx resource selection.

For stand-level analysis, forest data were quantified on vegetation plots at used and available locations for Canada lynx that were documented during winter and summer seasons from 2015-2017. Both summer and winter home range areas for lynx were identified. Used and available locations were sampled equally for both winter and summer. At each plot, several forest- and stand-level attributes were measured and recorded in the field including horizontal cover, pellet density of snowshoe hares, cover of grass, forbs, and shrubs, downed woody debris, stem density of understory by species and overall, canopy cover, and tree density and size for larger-sized trees. The Forest Vegetation Simulator (FVS) was used to calculate a variety of forest metrics commonly used for local forest management. Functional responses in habitat use provided important insight concerning how Canada lynx altered their use of forest resources as the

resource changed in availability. A summary of information was developed to characterize forest metrics at used and available lynx locations during the winter and summer.

Study Results

The information collected for the lynx study successfully explains and models what lynx are selecting and not selecting (i.e., avoiding) in spruce-fir ecosystems on the Forest (Squires et al. 2018). The Resource Selection Function (RSF) model successfully explains 95% of the winter lynx use in the study area, with approximately half of the total study area (49.9%) being selected for and half (50.1%) less selected. The West Fork Fire Complex is not included in the RSF model. Based on GPS locations from individual lynx, however, it is evident that collared lynx are avoiding the fire landscape at this time. An exception to this involves unburned islands of forest vegetation within but close to the burn perimeter.

Based on the model, winter use is best explained by a combination of abiotic factors and forest vegetation factors. Approximately half of the lynx use is explained by abiotic factors such as precipitation and landscape roughness, while the vegetation factors include dead forest canopy comprised of larger trees, aspen canopy, a subcanopy of subalpine fir and small spruce, and the presence of Douglas-fir. However, the presence of Douglas-fir is a negative relationship, indicating that lynx are avoiding dryer sites that contain this species. Of the vegetation factors lynx are selecting for, the presence of subalpine fir in the subcanopy is the most significant. Dense horizontal cover conditions of at least 45% are primarily being selected by lynx, which suggests that lynx are actively selecting forest stands with high horizontal cover values that also support high snowshoe hare densities. Reproduction has also been documented within areas of extensive overstory mortality. Both lynx use areas and reproduction areas sometimes overlap with habitat areas that are currently considered unsuitable habitat on a coarse scale, suggesting that new definitions of suitable and quality habitat in forests heavily influenced by bark beetles is warranted.

Key Findings from Current Research

The following results from completed and ongoing research studies on and adjacent to the Forest concerning snowshoe hare distribution; lynx diets, distribution, and habitat use:

- Snowshoe hare occupancy is reduced slightly due to high degree of overstory mortality from spruce beetles (Ivan et al. 2017).
- Red squirrel occupancy significantly decreases due to overstory mortality due to spruce beetle (Ivan et al. 2017).
- Bullets number 1 and 2, above, are notable because typically 90%+ of lynx winter diet is snowshoe hare, while red squirrel is < 10%. During periods of low hare abundance (2006-09) when female lynx did not produce litters of kittens, the diets switched to consist of up to 72% red squirrels (Ivan and Shenk 2016).
- A recent mark recapture study on the Forest found that snowshoe hare densities average more than twice the density known anywhere else in Colorado. This may be related to understory release from overstory mortality (Ivan et al. 2017).
- There are 12 locations in the state of Colorado that are consistently occupied by lynx, over half of these (58%) occur wholly or partially on the Forest (J. Ivan data in Squires et al. 2018).
- Despite the high degree of overstory mortality, lynx on the Rio Grande National Forest tend to demonstrate some site fidelity and remain and produce litters of kittens where they have done so in the past. This indicates that location is important in the context of management activities (Ivan et al. 2017).

- Lynx movement paths further display the importance of the Forest for within-home range movements, and long range movements up through North Pass area and Monarch Pass (Ivan et al. 2017).
- Documented lynx kittens at all dens located indicates lynx are reproducing in spruce-fir forests with extensive overstory mortality.
- Resource selection functions defined a 95% use area for lynx on the Rio Grande National Forest, which identified the top covariates of winter use selection. Understory density describes 50% of winter selection. Lynx are selecting for areas with > 45% understory horizontal cover (Squire et al. 2018). ***This is a new finding and forms the basis for a forest plan direction. Subalpine fir (ABLA) is the primary understory component preferentially selected by lynx, but use also includes small dense spruce and aspen mix.***
- Large dead trees are a key component of selected habitat and usually in association with understory. Remaining live trees are important (Squires et al. 2018).

Ongoing Endangered Species Act coordination with the U.S. Fish and Wildlife Service is occurring on the proposed new approach for the Canada lynx and management direction on the Forest.

References

Ivan, J. S., and T. M. Shenk. 2016. Winter diet and hunting success of Canada lynx in Colorado. *Journal of Wildlife Management* **80**:1049-1058.

Ivan, J., M. Rice, T. Shenk, D. Theobald, and E. Odell. 2017. Predictive map of Canada lynx use in Colorado. Colorado Parks and Wildlife unpublished report. 8 pp + tables and figures.

Squires, J.R., J. Ivan, J. Holbrook, R. Lawrence, S. Savage, and R. Ghormley. 2018. Habitat relationships of Canada lynx in spruce bark beetle impacted forests – analysis summary 19March 2018. USDA Forest Service internal report for the Rio Grande National Forest. Rocky Mountain Research Station, Missoula. MT. 34 p. including tables and figures.